

PHYSICS



EXAM QUESTION PACK

P1.2 CHANGES OF STATE

SCORE

/120

PERCENTAGE

%

STEMUP

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Gateway Physics A (9-1)

Changes of state

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate
forename

Candidate
surname

Centre number

Candidate number

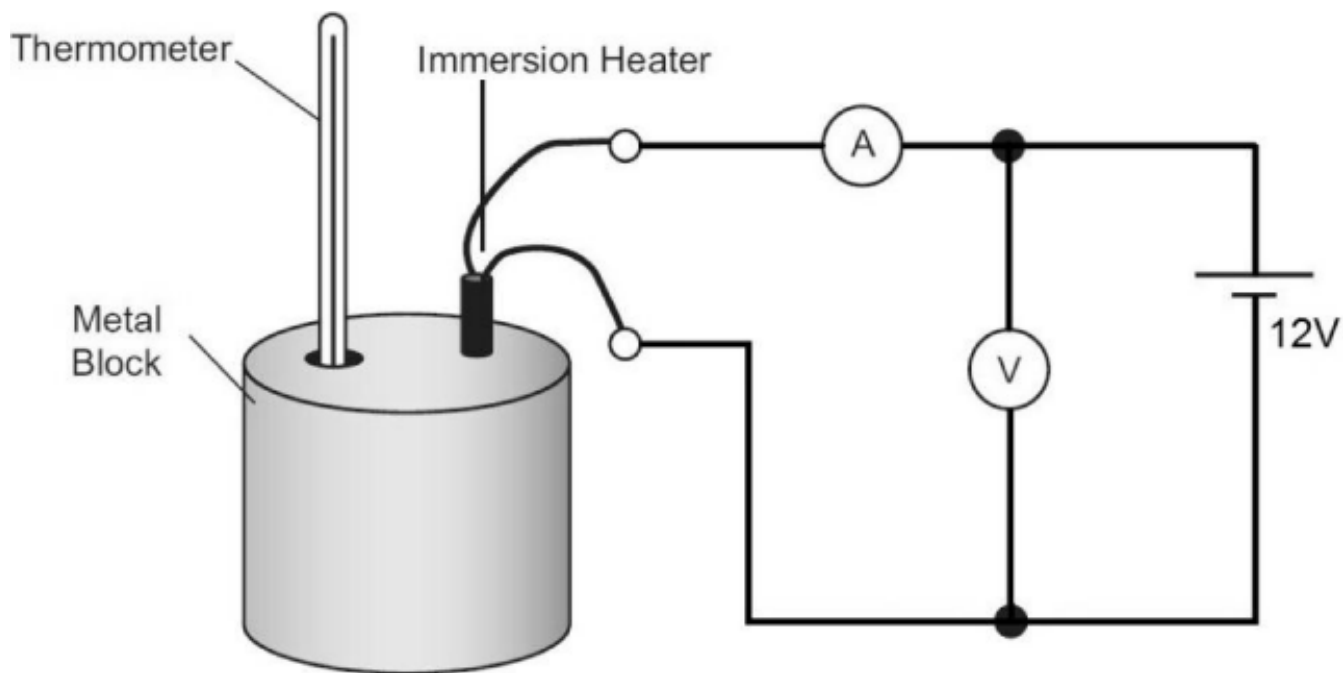
INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **120**.
- The total number of marks may take into account some 'either/or' question choices.

1(a) A student completes an experiment to find the specific heat capacity of a metal.



(i) The student takes voltage and current measurements.

Suggest **three** other measurements they need to take?

----- [3]

(ii) Describe how these measurements could be used to determine the specific heat capacity of the metal.

----- [2]

(b) The value obtained from the experiment is much higher than expected.

Suggest **two** reasons how this could have occurred and suggest **two** improvements to the experimental procedure.

[4]

2(a) Alex has two radiators in her home. They are filled with 10 kg of different liquids.

oil-filled radiator  Heater contains 10 kg of oil 1000 W heater	water-filled radiator  Heater contains 10 kg of water 1500 W heater
--	---

The table below shows information about oil and water.

Material	Specific heat capacity (J/kg°C)	Freezing point (°C)	Boiling point (°C)
Oil	1 700	−24	250
Water	4 200	0	100

Alex's conservatory can be very cold.

Sometimes it can get as low as −6 °C.

Alex thinks that the oil radiator may be better for the conservatory.

Suggest why.

[1]

(b) Both radiators in a home have a 'cut-out' which prevents them getting hotter than 60 °C.

Suggest why.

[1]

(c) Alex does a calculation.

She knows that the oil heater produces 800 J of energy each second.

Calculate the energy produced by the oil heater in 10 minutes.

answer: _____ J [2]

(d)

(i) Alex wants the oil heater to heat up by 40°C.

How much energy is needed? Show your working.

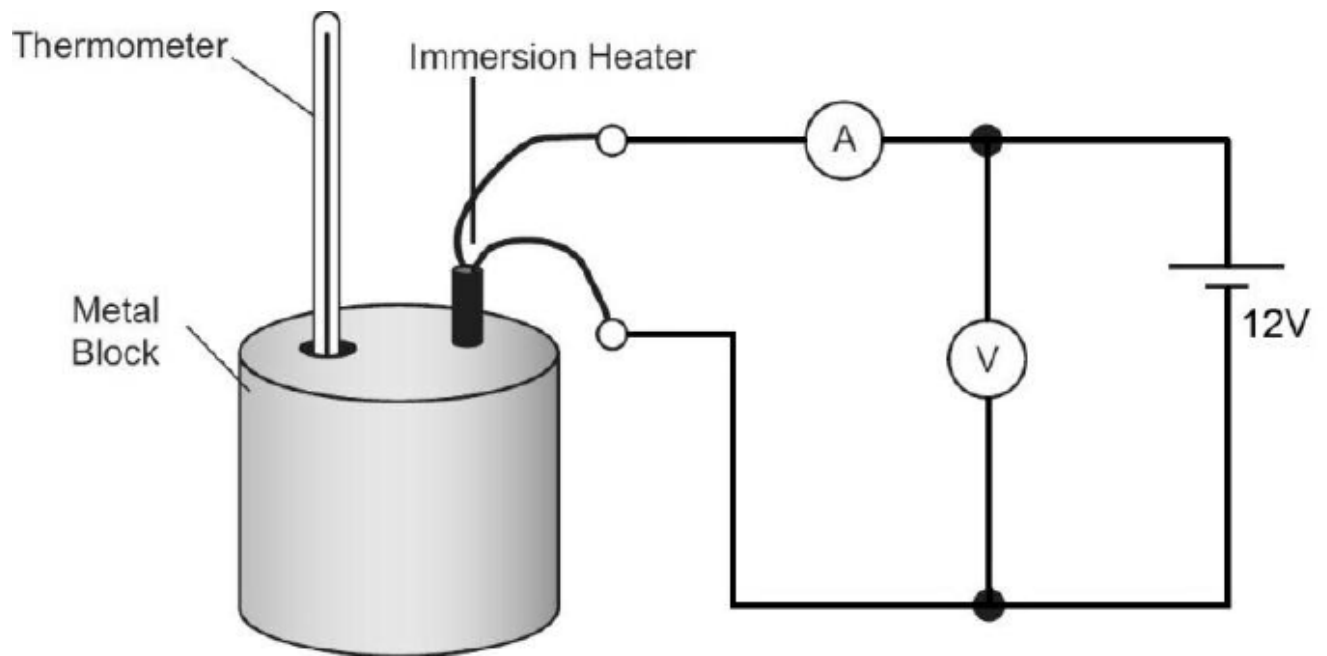
answer: _____ J [2]

(ii) She supplies enough energy to heat up the oil radiator by 40°C but it only heats up to 32°C.

Suggest two reasons why.

[2]

3(a) A student completes an experiment to find the specific heat capacity of a metal.



- (i) The student takes voltage and current measurements.

Suggest **three** other measurements they need to take?

----- [3]

- (ii) Describe how these measurements could be used to determine the specific heat capacity of the metal.

----- [2]

(b) The value obtained from the experiment is much higher than expected.

Suggest **two** reasons how this could have occurred and **two** improvements to the experimental procedure.

[4]

4 The plastic beaker has a mass of 0.2 kg and the specific heat capacity of the plastic is 1680 J / kg °C.

The water has a mass of 0.6 kg and its specific heat capacity is 4200 J / kg °C.

The energy from the microwave is initially absorbed by the water which then heats the plastic beaker.

The plastic beaker and water experience different temperature rises.

The plastic beaker gains 13 440 J and the water gains 151 200 J.

(i) Calculate the temperature rise of the water and the temperature rise of the plastic beaker.

water

.....

temperature rise of water °C

plastic beaker

.....

temperature rise of plastic beaker °C

[2]

(ii) Heating the plastic beaker in the **microwave oven** results in the plastic having a lower temperature rise than the water.

Suggest a reason why.

.....

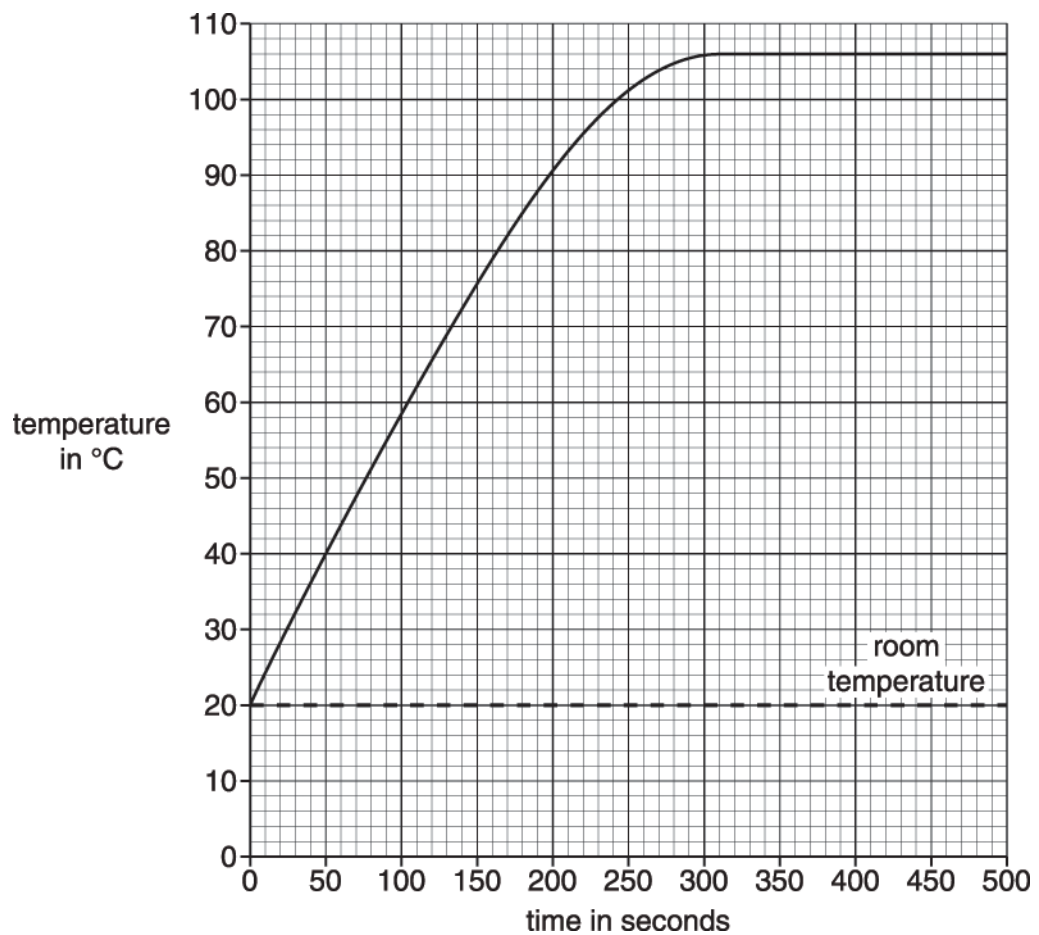
..... [1]

5 Sophia wants to buy a new kettle.

She is not sure which one to buy.

The two kettles in the table are identical, apart from the material they are made out of.

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Write down the time interval during which all of the energy supplied was used to change the state of the liquid, and explain how the energy supplied causes this change of state.

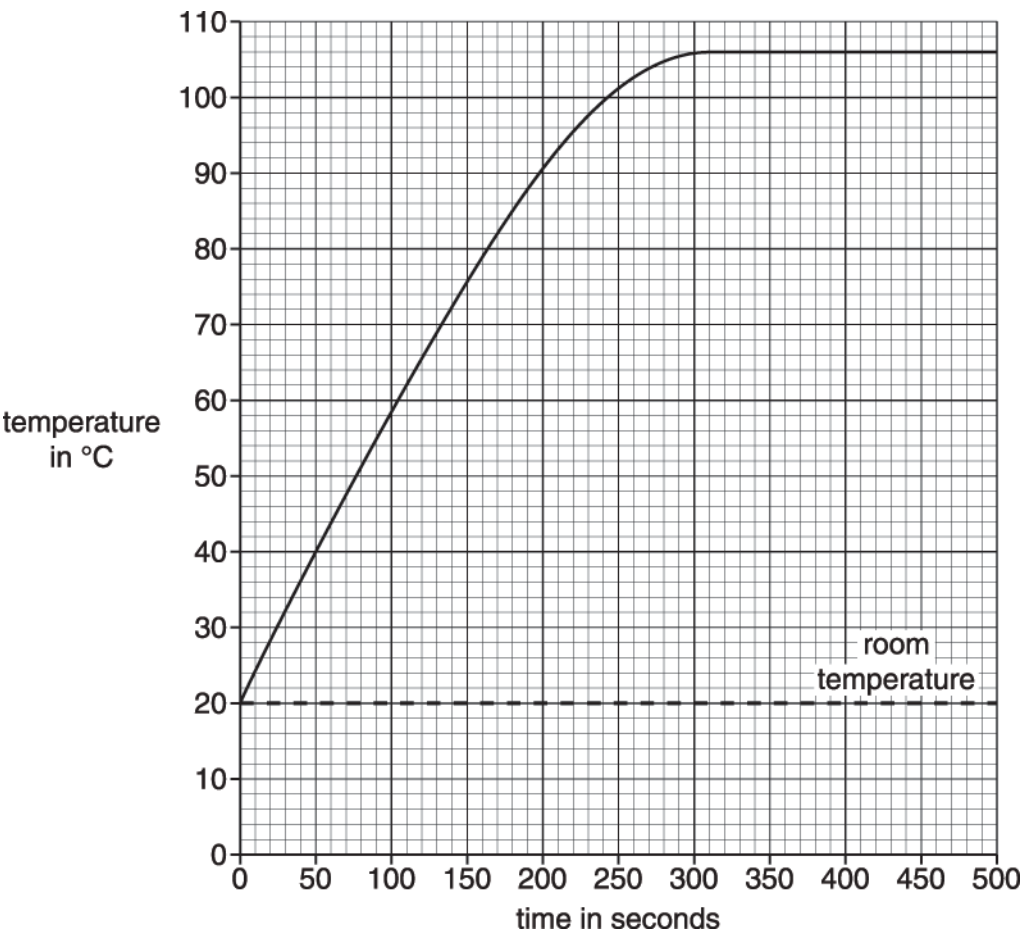
time interval is from _____ seconds to _____ seconds

explanation _____

[2]

7(a) Layla heats a beaker containing a liquid and records its temperature.

Look at the graph of her results.



Layla concludes that the liquid boiled during the experiment.

How does the graph show this?

----- [1]

(b) What is the boiling point of the liquid?

answer ----- $^{\circ}\text{C}$.

[1]

8(a) Dave experiments heating different materials.

He needs to choose a heater to warm some water.

The table shows how much energy different heaters supply in 600 seconds.

Heater	Energy supplied in joules
A	5000
B	10 000
C	20 000
D	25 000
E	35 000

Dave needs to increase the temperature of 0.6 kg of water by 12°C in 600 seconds.

Water has a specific heat capacity of 4200 J / kg°C.

Do a calculation to find out which heater Dave needs. Show your working.

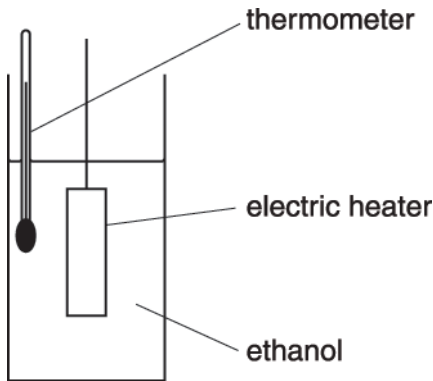
----- J

The heater Dave needs for this is -----

[2]

(b) Dave needs to boil some ethanol. He uses an electrical heater.

Look at the diagram.



- (i) The ethanol is at its boiling point.

Dave measures the temperature of the ethanol as it boils.

What happens to the temperature of ethanol when it is boiling?

-----[1]

- (ii) The specific latent heat of ethanol is 850 J / g .

Calculate the energy needed to boil 12 g of ethanol.

answer ----- J

[2]

- (iii) When Dave does this experiment he finds that he needs more energy to boil the ethanol than he expected.

Suggest reasons why.

-----[2]

9(a) Dave experiments heating different materials.

He needs to choose a heater to warm some water.

The table shows how much energy different heaters supply in 600 seconds.

Heater	Energy supplied in joules
A	5000
B	10000
C	20000
D	25000
E	35000

Dave needs to increase the temperature of 0.6 kg of water by 12 °C in 600 seconds.

Water has a specific heat capacity of 4200 J/kg °C.

Do a calculation to find out which heater Dave needs. Show your working.

----- J
The heater Dave needs for this is ----- [2]

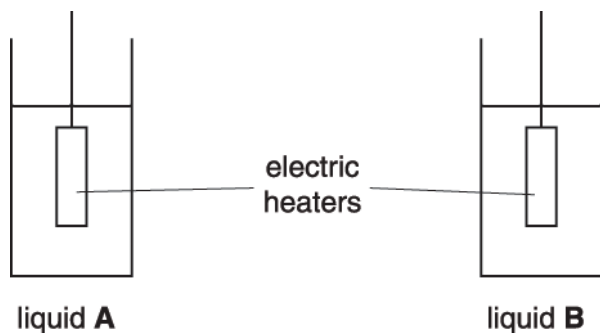
(b) Dave's teacher gives him two different liquids to boil.

They have different specific latent heats.

Specific latent heat of water = 2260 J/g
Specific latent heat of ethanol = 850 J/g

Unfortunately, he gets the two liquids confused. He cannot tell which liquid is which.

He heats up both liquids until they start to boil.



Dave then measures how much mass is lost from each liquid when he heats them for the same time.

Look at his results.

Liquid	Energy supplied for boiling in J	Mass of liquid lost in g
A	48000	20
B	48000	53

- (i) Use a calculation to show which liquid is water.

----- [2]

- (ii) When liquids boil, energy is transferred but there is no temperature change.

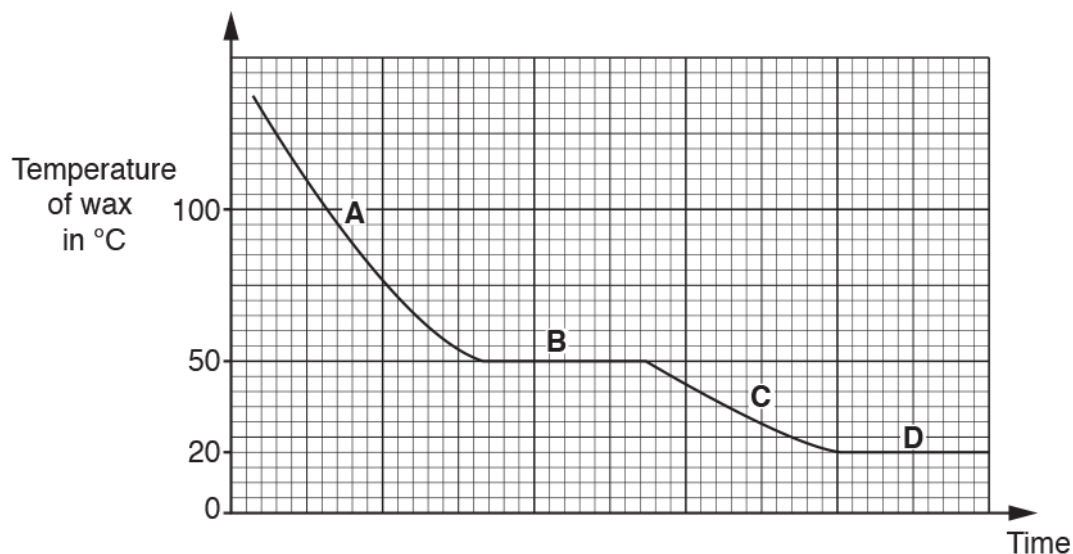
Write down the name of **another** process in which this happens.

----- [1]

10(a) Fin lets some **liquid** wax cool until it reaches room temperature at 20°C.

He measures the temperature of the wax as it cools.

Look at the graph of his results.



Explain what happens at **B** on the graph.

----- [2]

(b) Explain why the graph is constant at **D**.

----- [2]

11(a) Calculate the energy needed to change the state of 3.5 kg of water into steam.

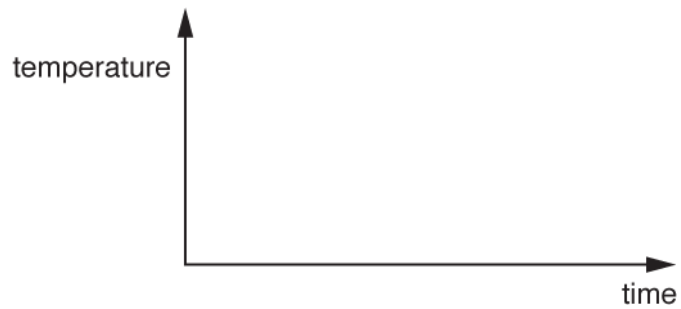
The specific latent heat for boiling water is 2 260 000 J/kg.

Answer J

[2]

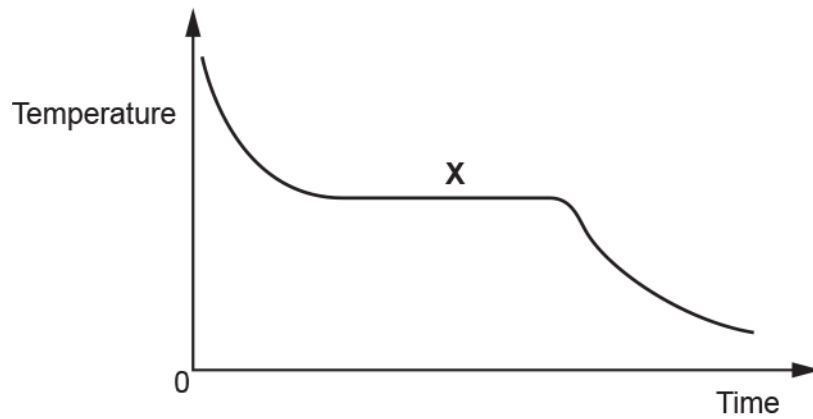
(b) This change of state from water into steam can be sketched on a temperature / time graph.

Sketch the line and describe what it shows.



[1]

12 A student studies how the temperature falls when a liquid cools.



What is happening at point X on the graph?

- A Boiling
- B Freezing
- C Melting
- D Subliming

Your answer

[1]

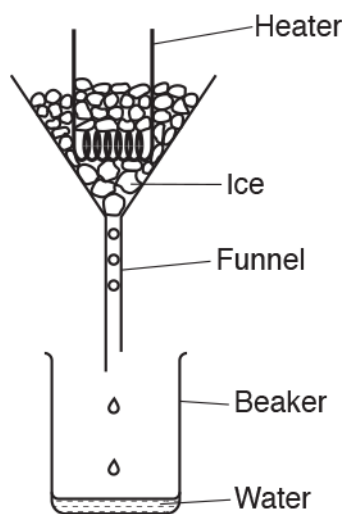
13(a) The students find that 250 g of ice takes 95 kJ of energy to change state.

Calculate the specific latent heat.

Answer = ... J/kg [3]

(b) Two students design an experiment to find the specific latent heat of water.

They set up their equipment as shown in the diagram.



The students also have access to a power supply, a voltmeter, an ammeter, a stop-clock and a top-pan balance.

* Explain how the students could use this equipment to determine an accurate value for the specific latent heat of water.

[6]

- 14 A wooden block has a mass of 2 kg and a specific heat capacity of 2000 J/kg °C.

Calculate the energy needed to raise its temperature by 6 °C.

Use the equation:

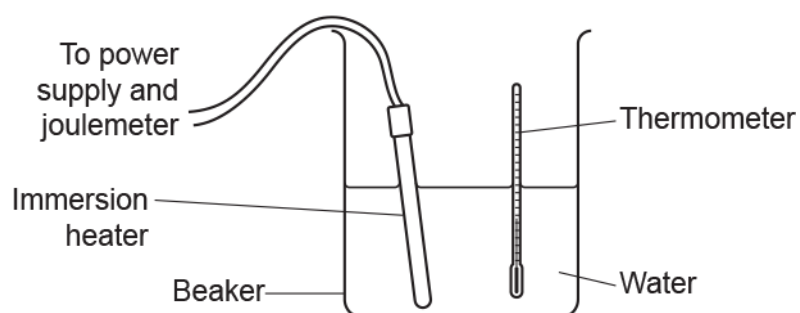
Change in thermal energy = Mass × Specific Heat Capacity × Change in Temperature

- A 1 200 J
- B 2 400 J
- C 12 000 J
- D 24 000 J

Your answer

[1]

- 15(a) A student completes an experiment to find the specific heat capacity of water.



He heats up 1 kg of water, using an immersion heater. He measures the temperature rise and calculates the specific heat capacity of the water.

Attempt	Energy supplied	Temperature rise	Specific heat capacity
---------	-----------------	------------------	------------------------

	(J)	(°C)	(J/kg °C)
1	10 000	2	5000
2	21 000	4	5250
3	44 000	8	5500

(i) Calculate the **mean** specific heat capacity.

Answer = ... J/kg °C [1]

(ii) Describe the conclusions that can be drawn from the data.

----- [3]

(b) The actual value for the specific heat capacity of water is 4200 J/kg °C.

(i) Explain why the mean specific heat capacity calculated in (a)(i) is higher than the actual value.

[2]

(ii) Write down **two** problems with this experiment **and** suggest how they could be solved.

Use the diagram and results table to help you.

Problem 1 -----

Solution -----

Problem 2 -----

Solution -----

[4]

16(a) A student puts an ice cube into a beaker. The mass of the ice cube is 40 g.

The ice cube melts.

(i) Write down the mass of the water produced.

Mass = ... g [1]

(ii) Explain your answer to (i).

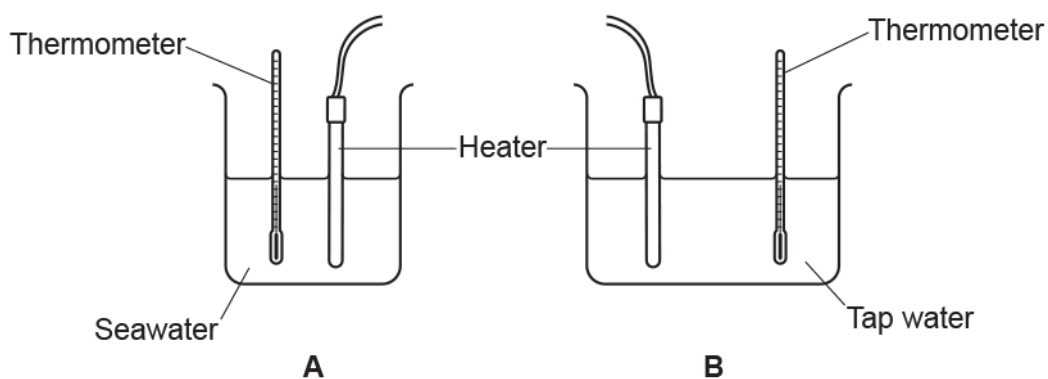
----- [2]

(b) Describe **one** difference between a **physical change** and a **chemical change**.

----- [1]

(c) A student does an experiment to find the difference between the specific heat capacities of seawater and tap water.

The student places a heater and a thermometer into two beakers, **A** and **B**. Look at the diagram.



(i) There are 5 steps to the method for this experiment.

Complete the missing steps for this method.

Step 1 – Put seawater into beaker and tap water into beaker .

Step 2 –

Step 3 –

Step 4 –

Step 5 – Calculate the temperature change of beaker and beaker .

[3]

(ii) Suggest **one** mistake the student made when choosing their equipment.

..... [1]

(iii) Suggest **two** improvements to the method followed.

1

2

[2]

17(a) A student puts an ice cube into a beaker. The mass of the ice cube is 40 g.

The ice cube melts.

(i) Write down the mass of the water produced.

Mass = ... g [1]

(ii) Explain your answer to (i).

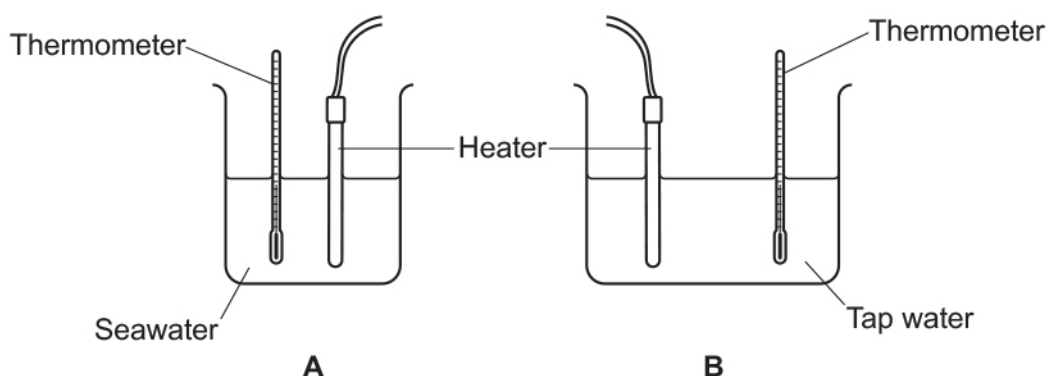
----- [2]

(b) Describe **one** difference between a **physical change** and a **chemical change**.

----- [1]

(c) A student does an experiment to find the difference between the specific heat capacities of seawater and tap water.

The student places a heater and a thermometer into two beakers, **A** and **B**. Look at the diagram.



- (i) There are 5 steps to the method for this experiment.

Complete the missing steps for this method.

Step 1 – Put seawater into beaker **A** and tap water into beaker **B**.

Step 2 –

Step 3 –

Step 4 –

Step 5 – Calculate the temperature change of beaker **A** and beaker **B**.

[3]

- (ii) Suggest one mistake the student made when choosing their equipment.

..... [1]

- (iii) Suggest **two** improvements to the method followed.

1

2

[2]

18 *A student does an experiment using 0.2 kg of water.

Here is some information from the experiment:

The aim is to find the energy needed to raise the temperature of the water by 20 °C.

An electrical heater is used to heat the water. The temperature of the water increases by $20\text{ }^{\circ}\text{C}$.

The **specific heat capacity** of water is $4\,200\text{ J / kg }^{\circ}\text{C}$.

Describe how the student should carry out the experiment, including the equipment used.

In your answer calculate the change in internal energy for the water.

You may include a diagram in your answer.

[6]

19 A student investigates what happens when she heats a beaker of water.

	The temperature increases	The state changes	The energy stored in the water changes
A	✓	✓	✓
B	✓	x	x
C	x	✓	x
D	x	x	✓

Which row in the table describes what **could** happen when the water is heated?

Your answer

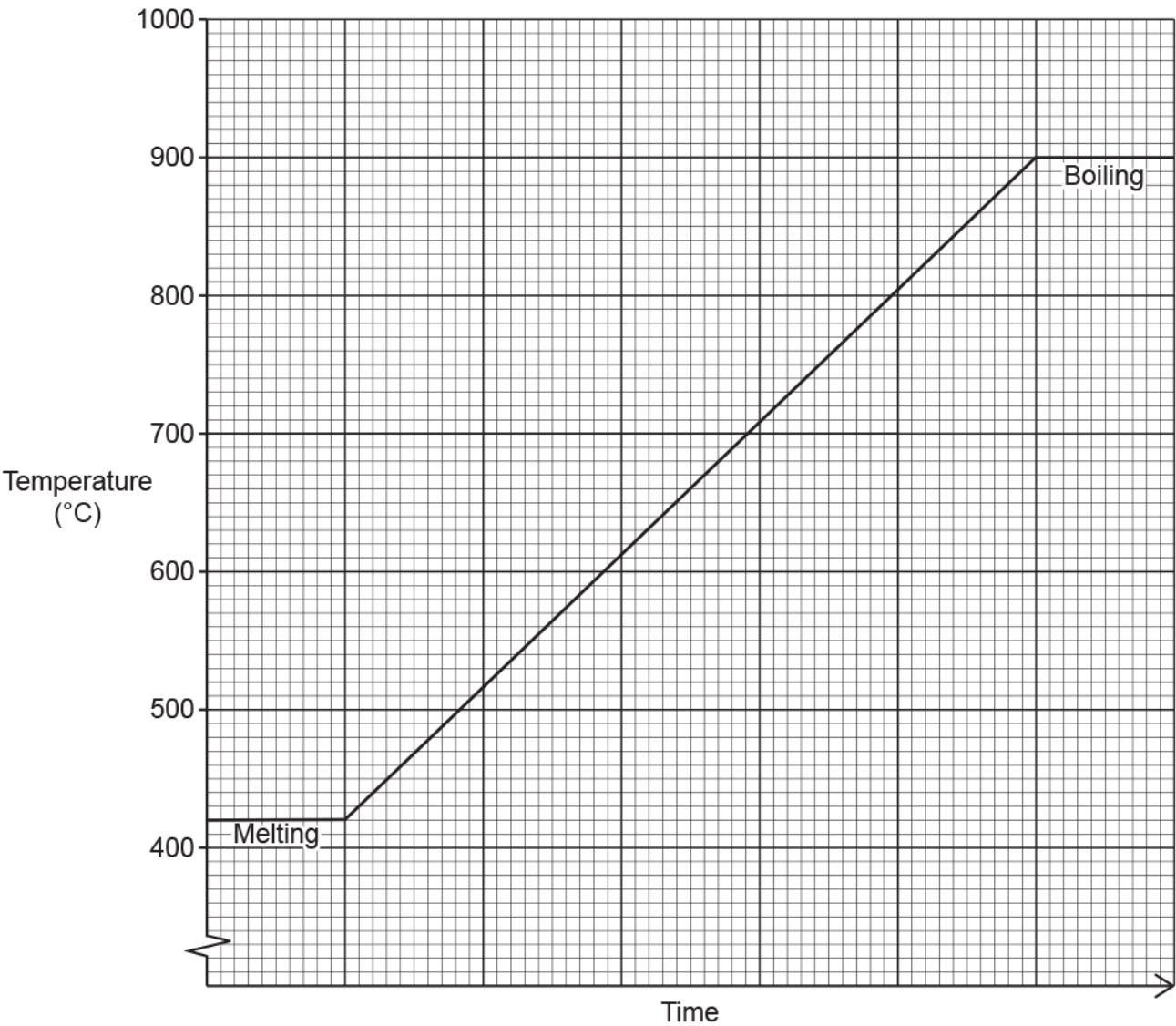
[1]

20(a) The table shows the specific heat capacities of different materials.

Material	Specific heat capacity (J / kg °C)
Copper	330
Brass	380
Zinc	385
Nickel	440
Concrete	880
Concrete	913

A scientist heats an unknown substance from a solid to a liquid.

The graph shows how the temperature of the substance varies with time.



The scientist has 2.5 kg of the substance and records that it takes 462 kJ of energy to increase it from the lowest to the highest temperature in the liquid state.

Use the graph to calculate the specific heat capacity of the substance.

Suggest what material it could be from the table.

Specific heat capacity = ... J / kg °C

Material = ...

[5]

(b) Suggest **two** reasons why the scientist cannot be certain that the substance has been identified correctly.

1

.....

.....

2

.....

.....

[2]

(i) **Table 21.1** gives some information about a kettle.

Energy transferred to the kettle	525 000 J
Mass of water	1.2 kg
Starting temperature of water	25 °C
Final temperature of water	100 °C
Specific heat capacity of water	4200 J / kg °C

Table 21.1

Calculate the efficiency of the kettle described in **Table 21.1**.

Give your answer as a percentage.

Use an equation from the data sheet.

Efficiency = ... % **[5]**

(ii) Explain why the efficiency of the kettle is less than 100%.

----- **[1]**

22 Energy is needed to change ice into water.

Calculate the energy needed to change 5 kg of ice into water.

Use an equation from the data sheet to help you.

Specific latent heat of melting = 3.34×10^5 J / kg.

- A 16.7 J
- B 1670 J
- C 1 670 000 J
- D 1 670 000 000 J

Your answer

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	Temperature rise or start and end temperatures (1) Time that the heater is switched on (1) Mass of the block (1)	3	
		ii	Reference to: energy = voltage $\times$ current $\times$ time (1) SHC = energy / (mass $\times$ temp rise) (1)	2	
	b		Any two reasons and any two improvements Reasons Heat escapes to the surroundings (1) Part of the immersion heater is outside of the block (1) Poor thermal contact between the immersion heater and block (1) It takes time for the thermometer to reach its maximum temperature (once the heater is turned off) (1) Improvements Lag / insulate the aluminium block (1) Make sure all of the heater is in the block / use a smaller heater (1) Use petroleum jelly to transfer heat between the immersion heater and the block (1) Wait until the maximum temperature is reached (1)	4	Max 2 reasons and 2 improvements ALLOW (idea of) residual heat not reaching the block before the final temperature is recorded.
			Total	9	
2	a		Oil will not freeze (as easily as water) / ORA (1)	1	
	b		Reduces risk of burns to people / children (1)	1	
	c		Time conversion: $10 \times 60 = 600$ seconds (1) $800 \times 600 / 480\,000$ (J) (1)	2	ALLOW 480 (kJ)
	d	i	Substitute into formula for specific heat capacity / $10 \times 40 \times 1\,700$ (1) $680\,000$ (J) (1)	2	ALLOW 680 (kJ)

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	Any two from: Some energy used to heat the radiator case (rather than the oil) (1) Energy passed from oil to air in room / oil undergoes cooling whilst heating up (1) Energy is dissipated to surroundings (1) It is not 100% efficient at transferring energy (1)	2	
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
3	a	i	Temperature rise or start and end temperatures (1) Time that the heater is switched on (1) Mass of the block (1)	3	
		ii	Reference to: energy = voltage $\times$ current $\times$ time (1) SHC = energy / (mass $\times$ temp rise) (1)	2	
	b		Any two reasons and any two improvements Reasons Heat escapes to the surroundings (1) Part of the immersion heater is outside of the block (1) Poor thermal contact between the immersion heater and block (1) It takes time for the thermometer to reach its maximum temperature (once the heater is turned off) (1) Improvements Lag / insulate the aluminium block (1) Make sure all of the heater is in the block/use a smaller heater (1) Use petroleum jelly to transfer heat between the immersion heater and the block (1) Wait until the maximum temperature is reached (1) Improvements Lag / insulate the aluminium block (1) Make sure all of the heater is in the block/use a smaller heater (1) Use petroleum jelly to transfer heat between the immersion heater and the block (1) Wait until the maximum temperature is reached (1).	4	Max 2 reasons and 2 improvements ALLOW (idea of) residual heat not reaching the block before the final temperature is recorded. ALLOW (idea of) residual heat not reaching the block before the final temperature is recorded.
			Total	9	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
4		i	water 60(°C) [1] beaker 40(°C) [1] but if answer is incorrect or incomplete then: either beaker t = $\frac{13\,440}{0.2 \times 1680}$ scores [1]	2	Allow the energies being used the wrong way round. — so gives 5.3(°C) and 450(°C) [1] Examiner's Comments This was a well answered question about calculating temperature rises.
		ii	(only) water (particles) absorbs microwaves [1] (only) water is heated by the microwaves [1]	1	ignore microwaves absorb water
		ii	beaker does not absorb / not heated by microwaves [1]		allow hot water heats the beaker / plastic heated indirectly [1] Examiner's Comments The candidates needed to say that the microwaves are absorbed by the water (rather than the plastic beaker). Some just said that the microwaves penetrated the beaker but failed to say that none were absorbed. Many referred to plastic being a poor conductor to explain their answer. Also the 'low SHC of plastic' was referred to unsuccessfully in many answers. It was rare to see explanations in terms of plastic not absorbing microwaves [1].
			Total	3	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
5	Level 3: (5 – 6 marks) Full quantitative AND a qualitative comparison. Quality of written communication does not impede communication of the science at this level. Level 2: (3 – 4 marks) Partial quantitative comparison OR qualitative comparison showing alloy has greater mass but smaller specific heat capacity. Quality of written communication partly impedes communication of the science at this level. Level 1: (1 – 2 marks) Idea of same mass of water OR water rises in temperature by the same amount OR same energy needed Quality of written communication impedes communication of the science at this level. Level 0: (0 marks) Insufficient or irrelevant science. Answer not worthy of credit.	6	This question is targeted up to grade A* Indicative scientific points at level 3 may include: relevant points for level 1 and level 2 and • idea that heat capacity / energy is the same for each • correct calculation to show heat energy capacity is the same for each e.g. $400 \times 1.5 \times 80 = 500 \times 1.2 \times 80$ $400 \times 1.5 = 500 \times 1.2$ Indicative scientific points at level 2 may include: • alloy has a smaller specific heat capacity • alloy has greater mass • stainless steel has a larger specific heat capacity • stainless steel has smaller mass • heat capacity / (energy) correctly calculated e.g. $400 \times 1.5 \times 80$ $500 \times 1.2 \times 80$ Indicative scientific points at level 1 may include: • mass of water is the same / mass of water in each kettle is 1.8 kg • temperature rise of water in each kettle is the same / water rises from 200C to 1000C in each kettle / temperature rise of water in each kettle is 80°C • power of kettle is the same • same amount of water (1.8 kg) and temp rise (80°C) • water heating needs same energy for each kettle Use the L1, L2, L3 annotations in Scoris; do not use ticks. Examiner's Comments This was a six mark question targeted up

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					to A* Most candidates achieved level 1 by knowing that the power of the kettles and the mass of water in each kettle were the same. A significant number of candidates went on to say that the difference in mass between the kettles was not significant, which was incorrect. Similar statements about the specific heat capacity of the material of the two kettles were also made, again incorrect. About half the candidates realised that the effect of greater mass of kettle and lower specific heat capacity cancelled the smaller mass and higher specific heat capacity. Most of these candidates proved this by calculation to gain level 2. To achieve level 3, candidates needed to do the above calculation and give a full qualitative explanation of the two situations. The terms heat capacity and specific heat capacity were (incorrectly) freely interchanged by many candidates but this was not penalised.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6			300 (seconds) to 500 (seconds) (1) energy used to break intermolecular bonds / bonds between molecules (1)	2	allow 300 to 310 (1) allow overcome intermolecular forces ignore breaks intermolecular forces not intra-molecular forces ignore bonds between particles allow breaks bonds between liquid particles (1) both marking points are independent of each other Examiner's Comments Most candidates gave the correct values [1] but rather fewer could explain that intermolecular bonds were broken. Many said forces were broken [0] or that the energy was used to change state [0]. Also 'bonds were broken' failed to reach this marking point. Some candidates talked about the breaking of intermolecular bonds, but whilst the temperature was rising. Others mentioned change of state but did not talk about the breaking of intermolecular bonds.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a		the temperature stays constant after 300s / 5 min / near the end / later in the experiment / AW (1)	1	allow flat line (1) ignore straight line ignore liquid cannot get any hotter allow horizontal / levels off / zero gradient Examiner's Comments About half the candidates were able to explain how the graph showed that the liquid was boiling. Many different expressions were accepted to describe the temperature as steady for the last 200 seconds. Examiners, however, did not accept the word straight as a correct description as this does not suggest horizontal.
	b		106 (°C)	1	Examiner's Comments Most candidates gave the correct answer of 106°C.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8	a		30240 and 35000 heater or E (2) but if the answer incorrect or no heater selected $0.6 \times 12 \times 4200$ or 30240 (1)	2	no mark for just choosing E with no working or answer no mark for choosing E with an incorrect calculation Examiner's Comments Calculations were usually correct, but some correct answers failed to select the heater needed. Some candidates chose D but failed to recognise that D would not supply enough energy.
	b	i	idea that it stays the same (1)	1	allow reaches its maximum / does not go any higher ignore a given temperature value Examiner's Comments There was a low level of attainment in this question (only about 1/3 gained the mark). Incorrect answers stated that the temperature would rise. A smaller number of answers were centred on change of state.
		ii	10 200 (2) but if the answer incorrect 12×850 (1)	2	Examiner's Comments A very high number of candidates gained full credit. When errors did occur they were because of an attempt to convert 12g to kilograms or dividing the specific latent heat by the mass

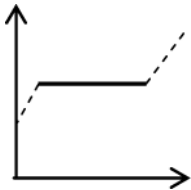
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	any two from: energy needed to heat beaker / heater (1) heat air / surroundings (1) counteract cooling / AW (1) idea of part of heater exposed / not in ethanol (1)	2	ignore efficiency ignore energy wasted or heat escapes unless qualified ignore greater mass amount of ethanol / s.l.h. greater than expected Examiner's Comments The last part of question 2 was poorly answered, with two mark answers at a premium. Incorrect answers often concentrated on the ideas of the ethanol having a higher than expected boiling point. Other wrong answers were about the energy needed to cause a change of state or to break intermolecular bonds. Few responses appreciated that some energy would be used to heat the heater or container or that energy would be lost to the air.
			Total	7	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
9	a		30240 (from the calculation) and E / the 35000 heater (2) but if the answer incorrect or no heater selected $0.6 \times 12 \times 4200$ or 30240 (1)	2	no mark for just choosing E with no working or answer no mark for choosing E with an incorrect calculation Examiner's Comments This question was answered successfully in several ways by 75% of candidates.
	b	i	$\frac{48000}{20}$ or 2260×20 and liquid A indicated or named scores (2) but $\frac{48000}{(53 \text{ or } 20)}$ or s.l.h. $\times$ (20 or 53) without comment or incorrect comment scores (1)	2	Allow correct rearrangements: Eg $\frac{48\ 000}{2260} = 21,2$ (38938) or 21 and liquid A [2] A chosen with incorrect calculation scores (0) Examiner's Comments This latent heat calculation was answered well by most candidates.
		ii	melting or freezing / solidification	1	allow condensation / sublimation allow acceptable named change of state ignore evaporation ignore liquid to gas / boiling Examiner's Comments Some candidates simply repeated the question here: eg. 'Boiling' or 'turning liquid to gas'. Evaporation was also common [0], as was 'change of state' [0], but just over half of the answers could name another change of state [1].
			Total	5	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10	a		solidifying (1) energy is given off due to a change in state / AW (1)	2	allow freezing (1) allow changing from liquid to solid (1) allow temperature staying the same (1)
	b		any two from: (approaches, stays) at room temperature (1) temperature difference is reduced / zero (1) no (net) transfer of energy (1)	2	
			Total	4	
11	a		7,910,000J / 7.91MJ / 7910kJ / 7.91×10^6 J (1) if incorrect or incomplete then: 3.5×2260000 (1)	2	allow correctly rounded answers to 2 significant figures
	b		horizontal line shown on graph (1)	1	allow written description which covers the marking point 
			Total	3	
12			B ✓	1 (AO1.2)	
			Total	1	

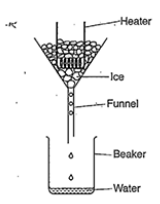
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13	a		FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 380 000 (J) award 3 marks SLH = $E \div m$ ✓ = $95000 \div 0.25$ ✓ = 380000 (J/kg) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	Rearranging equation $95 \div 250$ or 0.38 scores ✓ (evidence of rearranged formula) $95\ 000 \div 250 = 380$ scores ✓✓ Or $95 \div 0.25 = 380$ ✓✓ Or 380 ✓✓ <u>Examiner's Comments</u> Slightly over a half gained all 3 marks for this calculation. Some gained fewer marks because of power of 10 errors in conversions for example 360 [2] rather than 360 000 [3]. Others gained [1] for the correct rearrangement of the formula.
	b		Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) A detailed explanation of experimental procedure AND detailed discussion about accuracy <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) EITHER a detailed explanation of the experimental procedure OR detailed discussion about accuracy OR a brief explanation of the experimental procedure and simple discussion about accuracy <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some</i>	6 (AO 2 × 2.2) (AO 2 × 3.3a) (AO 2 × 1.2)	AO1.2 and AO2.2 Applies knowledge and understanding of how to use the equipment to find specific latent heat of water. For example: • Measure the initial mass / weight of beaker • Turn on the heater • Start timing • Use the voltmeter, ammeter and stopclock to calculate the energy supplied ($E=VIt$) • Turn off the heater • Stop timing • Use a balance to measure the mass of the beaker and melted ice • Subtract the original mass of the beaker to find the mass / weight of the melted ice / calculate mass / weight of melted ice • Calculate specific latent heat by dividing energy by mass AO3.3a Analyses information and ideas to develop experimental procedures and consider accuracy of the experiment. For example: • Make sure that the heater is always covered with ice • Insulate / put lid on the funnel to reduce

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	evidence. Level 1 (1–2 marks) Brief explanation of the experimental procedure OR simple comment about accuracy <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>		heat losses • Make sure that the mass of water produced is sufficiently large – run the experiment for long enough • Repeat the experiment to minimise (random) errors Examiner's Comments This six mark level of response question is the only one on this paper. It gave the full range of marks and discriminated well at higher grade demand with about 10% giving level 3 answers and gaining 5 or 6 marks. The procedure was explained quite well with many gaining level 2 scores. A few were very brief with the description (level1) and did a little more than relate the equipment given in the question. Most got the idea of measuring the ice melted, measuring the voltage and current (and multiplying them to get power). Many showed how to calculate the energy and then use this to calculate the specific latent heat (SLH). Very few wrote about accuracy and therefore did not get level 3 rewards at all. A few misread the question and wrote about specific heat capacity (SHC) rather than SLH. As in previous qualifications candidates highlighted key words in the question. This helped them focus their attention on structuring their answers in a clear and concise manner thus gaining marks along the way. Exemplar 4 The students can use this equipment to get an accurate value as first of all they should use the top pan balance to work out the weight of ice they are melting. Then they should connect the voltmeter and ammeter up to the heater and power supply in a circuit before using the formulae power = current x resistance to work out the power. The stop watch should be used to time how long it takes for the ice to melt in seconds. When all the ice has melted & multiply the value for power by the amount of time to work out how much energy was supplied in total. Then use the formula specific latent heat = energy supplied / mass to calculate the specific latent heat of the ice.

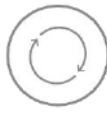
Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			but often restates the information in the diagram. For example connects the ammeter and voltmeter to the heater – rather than connects the voltmeter in parallel and the ammeter in series. The formula suggested seems a little insecure for a full level 2 answer so the candidate is credited 3 marks. Exemplar 5  They set up their equipment as shown in the diagram. $\text{latent heat} = \frac{\Delta \text{thermal energy}}{\text{mass}}$ $\text{power} = \text{current} \times \text{potential difference}$ $\text{energy} = \text{power} \times \text{time}$ The students also have access to a power supply, a voltmeter, an ammeter, a stop-clock and a top-pan balance. (a)* Explain how the students could use this equipment to determine an accurate value for the specific latent heat of water. - The students must find out the mass and the change in thermal energy during this experiment. - To do this they can create a circuit with the heater as the component. They should put the ammeter in series with the circuit to measure the current in amps. They should connect the voltmeter in parallel with the heater to measure the potential difference in volts. - They should time how long it takes for all of the water to melt using the stop clock. - Then they should use the equation $\text{power} = \text{current} \times \text{potential difference}$ and use their values to find the power. Then they should use the equation $\text{energy transferred} = \text{power} \times \text{time}$ to find out the change in energy. (continued on back) This answer clearly explains the method in some detail. It describes the measurements taken and the calculations and formulae needed. It does not attempt to describe anything about accuracy so it is limited to level 2 and is credited 4 marks.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	9	
14			D ✓	1 (AO 2.1)	<u>Examiner's Comments</u> Candidates were required to carry out a simple substitution into a given equation were generally answered well.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a	i	5250 (J/kg°C) ✓	1 (AO1.2)	Examiner's Comments Most candidates (≈ 90%) were able to calculate the mean specific heat capacity efficiently.
		ii	Any three from: specific heat capacity increases with temp rises ✓ specific heat capacity increases with energy supplied ✓ temp rise increases with energy supplied ✓ different amounts of energy were supplied ✓ all of the s.h.cs. are close together (within 5%) / within the range 5000 – 5500 ✓ the experiment was repeated / done 3 times ✓	3 (AO3 × 3.2b)	ALLOW other reasonable observation, e.g. s.h.c. increases with longer heating Examiner's Comments This question expected the candidate to describe the patterns in the tabulated data and to recognise that the table recorded values from three repeats of the experiment with the control variable changed. There were a number of different marking points to allowed candidates to achieve full marks. However, most candidates' answers were too brief and only described one or two possible conclusions.  AfL For this style of question which is assessing AO3 it is important to encourage candidates to write about a minimum of three different conclusions that could be drawn. The space provided is indicative of the expected answer, so in this example describing four “conclusions” briefly (Exemplar 4) would be a better approach than one “conclusion” described in greater detail (Exemplar 3). Exemplar 3 (ii) Describe the conclusions that can be drawn from the data. As the energy supplied increases the specific heat capacity also increases. ✓ [3]

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					Exemplar 4 (iii) Describe the conclusions that can be drawn from the data. As the energy supplied increases, so does the temperature. The specific heat capacity increases by an interval of 256.3 J kg⁻¹ °C⁻¹ after each attempt. Increased temperature and energy supplied causes the specific heat capacity to increase. [3]
	b	i	Any two from: more energy (than expected) heated the water ✓ energy losses must have occurred/not all the energy went into the water ✓ energy transferred to environment /AW ✓	2 (AO2 × 3.2b)	ALLOW heat for energy Examiner's Comments Only a very few candidates answered this question well. These candidates realised that a "higher" calculated value of specific heat capacity meant that more energy had to be transferred to the beaker than was expected. These candidates concluded that much energy had been lost to the environment.
		ii	Any two linked answers from: part of the immersion heater is out of the water ✓ make sure the heater is fully in the water/use a larger/deeper beaker ✓ beaker is not lagged/insulated ✓ lag/insulate the beaker ✓ there is no lid on the beaker ✓ put a lid on the beaker ✓ the temperature rises are quite small ✓ apply more energy to the water ✓ insufficient data ✓ take more readings ✓	4 (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b) (AO3.3a) (AO3.3b)	Examiner's Comments Most candidates appeared not to appreciate how the story of the topic being assessed was developed through Q18 and in particular how their answer to Q18(b)(i) should help them in answering Q18(b)(ii). Most candidates offered random comments unrelated to Q18(b)(i). A popular response was the suggestion that a Bunsen burner should be used rather than an electrical immersion heater.
			Total	10	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
16	a	i	40 (g) ✓	1 (AO3.2b)	<u>Examiner's Comments</u> Most candidates correctly stated that the mass was 40 g.
		ii	<u>Mass</u> before = <u>mass</u> after / <u>Mass</u> is conserved AW ✓ Explanation in terms of particle rearrangement / conservation of numbers of particles✓	2 (AO1.1 x2)	ALLOW no <u>mass</u> is lost ALLOW matter for mass ALLOW atoms/molecules for particles <u>Examiner's Comments</u> Most candidates were able to state that the mass was conserved; few candidates explained their answer in terms of the number of particles (atoms or molecules) not changing but particles are rearranging.
	b		Any one from: Original properties return if change is reversed for physical changes ✓ Chemical change can't be reversed (easily) OR physical change easily reversible✓ The substance after the change is the same as the substance before the change for physical changes ORA ✓	1 (AO1.1)	ALLOW in a chemical change particles join together in a different way <u>Examiner's Comments</u> Most candidates answered this question in terms of a physical change being reversible while a chemical change was not (easily) reversible. Some candidates confused their answers in terms of products.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	c	i	Any three from: Measure start/initial temperatures ✓ Turn on the heaters / heat water ✓ Measurements to determine energy or mass of water ✓ For a set time✓ Measure the final/end temperatures ✓	3 (AO2.2 x3)	IGNORE put thermometer or heater in beaker Initial can be implied ALLOW for a fixed temperature change ALLOW for a fixed temperature change, measure time <u>Examiner's Comments</u> Many candidates did not gain full marks on this question by repeating the question, e.g. place heater and thermometer in the beakers. Ideally candidates were expected to measure the temperature of both beakers at the start of the experiment before switching on the heaters <u>for a set time</u>. It was then expected that candidates would measure the temperature at the end. Other workable alternatives were allowed. Credit was also given for appropriate methods to measure the mass of the water or to determine the energy.
		ii	Any one from: Beakers are different sizes OR different volumes /mass of liquid in A and B ✓ Beakers are not insulated / no lids✓	1 (AO3.3a)	ALLOW Heater is not fully in the water <u>Examiner's Comments</u> Most candidates identified that the beakers were different sizes. Credit was also allowed for identifying that the beakers were not insulated or did not have a lid. Some candidates correctly referred to the heaters not being totally submerged.

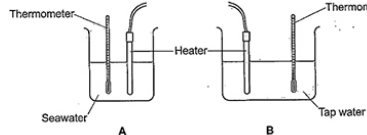
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	Any two from: Use beakers of the same size / same volume✓ Use same mass or volume of liquid✓ Stir water / keep distance from thermometer to heater fixed✓ Insulate the beakers or put the beakers on an insulating material ✓ Put a lid on the beakers ✓ Make sure the heater is fully inserted into the liquid ✓	2 (AO3.3b)	<u>Examiner's Comments</u> The majority of the candidates gained at least one mark for this question. One easy improvement was linked to the previous question. Examiners did not allow same amounts of water. Candidates need to use specific terms such as mass, or volume.
			Total	10	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
17	a	i	40 (g) ✓	1 (AO3.2b)	
		ii	<u>Mass</u> before = <u>mass</u> after / <u>Mass</u> is conserved AW ✓ Explanation in terms of particle rearrangement / conservation of numbers of particles ✓	2 (AO1.1x2)	ALLOW no <u>mass</u> is lost ALLOW matter for mass ALLOW atoms/molecules for particles
	b		Any one from: Original properties return if change is reversed for physical changes ✓ Chemical change can't be reversed (easily) OR physical change easily reversible ✓ The substance after the change is the same as the substance before the change for physical changes OR A ✓	1 (AO1.1)	ALLOW in a chemical change particles join together in a different way Examiner's Comments Question (a)(i) was correctly done by most candidates. Around half the candidates gained 2/2 in (a)(ii) where an explanation on the mass conservation in terms of particles was needed for the second mark (e.g. 'the same molecules are present'). . The most common misconception was that physical changes were hard to reverse but chemical changes were easy to reverse.
	c	i	Any three from: Measure start/initial temperatures ✓ Turn on the heaters / heat water ✓ Measurements to determine energy or mass of water ✓ For a set time ✓ Measure the final/end temperatures ✓	3 (AO2.2x3)	IGNORE put thermometer or heater in beaker Initial can be implied ALLOW for a fixed temperature change ALLOW for a fixed temperature change, measure time Examiner's Comments Many candidates did not read the stem to (c)(i) carefully. Exemplar 8 is a response where the quoted steps 2 and 3 are actually in the stems has having been done already. Fortunately, there were two

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			reasonable suggestions on the 'Sep 4' answer line, so the candidate gained 2 marks.  Misconception In practical skills questions many candidates want to describe the practical activity they did in the classroom rather than answering the question they have been given. It is important to read the stem to the question carefully, including any diagrams. In Exemplar 8 the candidate responses for Step 2 and Step 3 of their method had already been done. Fortunately Step 4 contained two reasonable suggestions so the candidate was given 2 marks. Exemplar 8 (c) A student does an experiment to find the difference between the specific heat capacities of seawater and tap water. The student places a heater and a thermometer into two beakers, A and B. Look at the diagram.  (i) There are 5 steps to the method for this experiment. Complete the missing steps for this method. Step 1 – Put seawater into beaker A and tap water into beaker B. Step 2 – <u>put the heaters in at the same time</u> Step 3 – <u>put the thermometers in</u> Step 4 – <u>take the temperature after a certain time</u> Step 5 – Calculate the temperature change of beaker A and beaker B. [3]

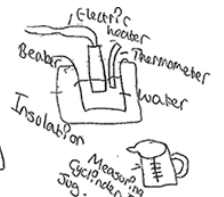
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	Any one from: Beakers are different sizes OR different volumes /mass of liquid in A and B ✓ Beakers are not insulated / no lids✓	1 (AO3.3a)	ALLOW Heater is not fully in the water <u>Examiner's Comments</u> Many candidate answers to (c)(ii) and (c)(iii) were linked, with the response to (c)(iii) correcting one of the errors in (c)(ii), and this appeared to be a good approach. Acceptable answers to (c)(iii) had to be related to the process in (c)(i), and not just a generic 'how to do a better experiment' comment.
		iii	Any two from: Use beakers of the same size / same volume✓ Use same mass or volume of liquid✓ Stir water / keep distance from thermometer to heater fixed✓ Insulate the beakers or put the beakers on an insulating material ✓ Put a lid on the beakers ✓ Make sure the heater is fully inserted into the liquid ✓	2 (AO3.3b)	<u>Examiner's Comments</u> Many candidate answers to (c)(ii) and (c)(iii) were linked, with the response to (c)(iii) correcting one of the errors in (c)(ii), and this appeared to be a good approach. Acceptable answers to (c)(iii) had to be related to the process in (c)(i), and not just a generic 'how to do a better experiment' comment.
			Total	10	

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
18	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed description of the procedure and the measurements (including a labelled diagram). AND Correct calculation of the change in thermal energy. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Detailed description of the procedure and the measurements (with a diagram). OR Description of the procedure and the measurements (with a diagram). AND Correct calculation of the change in thermal energy. <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Basic description of the procedure and the measurements. OR Correct calculation of the change in thermal energy. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>	6 (AO2×3 .3a) (AO2×2.2) (AO2×2.1)	AO3.3a Analyse information and ideas to develop experimental procedures • liquid placed in beaker • heater immersed in liquid • heater connected to power supply • insulation arranged to reduce heat loss • thermometer • instrument(s) to determine energy e.g. stopwatch, circuit AO2.2 Apply knowledge and understanding of scientific enquiry, techniques and procedures - measurements • Explanation of obtaining mass of 200 g • Initial temperature measured • Temperature rise / change / temperature after measured • Method to determine the energy e.g. use of joule meter / $E = ItV$ method / power of heater and time. AO2.1 Apply knowledge and understanding of scientific ideas to calculate change in thermal energy • use of $E = m \times c \times t$ • $E = 0.2 \times 4\,200 \times 20$ • $E = 16\,800\text{ J}$ <u>Examiner's Comments</u> This question gave candidates the opportunity to apply their knowledge and understanding of practical procedures related to specific heat capacity. The question is open ended so that candidates have the opportunity of demonstrating their knowledge as well as having the opportunity to structure their answers logically. This question stated “You may include a diagram in your answer.” A diagram of the experimental arrangement would have been very helpful. Many candidates did not include a diagram. The advantage of

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
			drawing a diagram is that it will also assist candidates in their procedures. Diagrams should be labelled. Several candidates drew diagrams with a beaker, heater and thermometer. Some candidates incorrectly drew diagrams of Bunsen burners heating water. The question also required candidates to calculate the change in internal energy for the water. Higher ability candidates stated the equation from the data sheet and then clearly substituted the numbers from the question before calculating the answer. Candidates who did not calculate the change in internal energy correctly often did not include an equation. The question gave candidates the opportunity to discuss practical procedures. Again, several candidates used insulation and adding a lid. Some discussed stirring the water. A circuit diagram showing how the electrical heater was connected would have been useful. For the highest marks, it was expected that candidates would explain how a mass of 0.2 kg was measured and how the energy could be measured experimentally. Some candidates did mention the use of a stopwatch. Exemplar 3 You may include a diagram in your answer. Change in Internal energy = $\text{mass} \times \text{SHC} \times \text{change in temp.}$ $0.2 \times 4200 \times 20 = 16800 \text{ J}$  The student should accurately measure out the water, then pour into beaker. Then put the heater into the water and the thermometer, making sure they don't touch otherwise it will make the test inaccurate. Then time the experiment and find out how much the water gives out a second. Then heater the water 20°C and stop the time and turn off heater. Make sure to read thermometer on eye level for most accuracy.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					This candidate has drawn a diagram showing the container is insulated with a heater and thermometer. The calculation is clearly shown using an appropriate equation. The candidate then describes the experiment; this could have included much more detail such as explaining how the water would be measured. This candidate hints at an energy determination when the energy per second of the heater is mentioned. The candidate also gives some extra detail when suggesting that the heater and thermometer should not touch. The description of the procedure lacked appropriate detail but the calculation was correct. The information given by the candidate was relevant and was presented with some structure. Overall this response was assessed as being a Level 2 response worth four marks.
			Total	6	
19			A	1 (AO2.1)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
20	a		FIRST CHECK THE ANSWERS ON ANSWER LINES If answer = 385 (J/kg°C) AND material = zinc award 5 marks $c = (E / m\theta) \checkmark$ $(\theta = 900 - 420 =) 480 (^{\circ}\text{C}) \checkmark$ $(c =) 462000 / (2.5) \times 480) \checkmark$ $(c =) 385 (\text{J/kg}^{\circ}\text{C}) \checkmark$ (substance is) zinc $\checkmark$	5 (AO1.2) (AO2.2) (AO2.2) (AO2.2) (AO3.2b)	ALLOW ecf for missing or incorrect unit conversion e.g. 0.385 (J/kg°C) for 3 marks (E = mcθ does not score a mark) ALLOW ecf for closest material to the answer calculated for shc if answer is incorrect. IGNORE another material quoted with its value from the table given as the answer unless workings shown
	b		Any two from: Not all substances are shown in the table / it could be a substance not in the table $\checkmark$ Named uncertainties/errors in the experiment $\checkmark$ It assumes all of the energy went to heat the material $\checkmark$ The value is (very) close to other values $\checkmark$ It assumes the substance is pure/not a mixture $\checkmark$	2 (AO2x3.1 b)	ALLOW there could be more than one substance with the same shc ALLOW assumes no energy transferred to other stores / no energy/heat loss ALLOW ecf from the part above ALLOW maximum of 1 mark for idea of results not repeated/reproduced
			Total	7	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
21		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 72 (%) award 5 marks Select from data sheet: change in thermal energy = mass × specific heat capacity × change in temperature (no mark) (change in thermal energy =) $1.2 \times 4200 \times 75$ ✓ (change in thermal energy =) 378 000 (J) ✓ (Recall: efficiency =) useful output energy transfer / input energy transfer OR (Efficiency =) $378\,000 / 525\,000$ ✓ (Efficiency =) 0.72 ✓ (Efficiency =) 72 (%) ✓	5 (AO1.2) (AO2.1) (AO1.2) (AO2.1) (AO1.2)	ALLOW ecf for incorrect thermal energy calculated ALLOW 4 marks for answer of 0.72 (%)
		ii	some energy is transferred to the (thermal energy store of the) kettle/surroundings/air ✓	1 (AO2.1)	IGNORE sound
			Total	6	
22			C	1 (AO2.1)	
			Total	1	